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RESEARCH IN THE UTILIZATION OF FARM PRODUCTS

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It is indeed a pleasure to be here with you this evening to discuss the subject of research on utilization of farm products. This topic is uppermost in the minds of many of us in the Department of Agriculture today because of the new emphasis on industrial research that is finding expression in the four regional research laboratories Congress has provided as a means to develop more profitable uses for surplus farm products and by-products.

I know the thought that is in your minds tonight is "What does this kind of research offer us in the way of increased outlets and better markets for our crops, particularly fruits and vegetables?" Now this is not a simple question to answer, but I will try to point out some of the lines of research planned for the new laboratories that should prove useful in providing new outlets, and more profitable ways of using certain of the crops of this area. Before doing this, however, it might be well to review briefly the history of this research development.

In 1938 Congress directed the Secretary of Agriculture to establish four regional research laboratories to search for new and wider industrial outlets and markets for farm commodities. This authority is granted under the "Agricultural Adjustment Act of 1938, Sec. 202 (a) to (e) inclusive. I shall quote a few sentences from this act—"The Secretary is hereby authorized and directed to establish, equip, and maintain four regional research laboratories, one in each major farm producing area, and at such laboratories, to conduct researches into and to develop new scientific, chemical and technical uses and new and extended markets and outlets for farm commodities and products and by-products thereof. Such research and development shall be devoted primarily to those farm commodities in which there are regular or seasonal surpluses, and their products and by-products." That paragraph is the guiding star to which we must keep our research wagon hitched in order to keep it on its intended course.

Section 202 (d) of this Act states further that "To carry out the purposes of subsection (a), the Secretary is authorized to utilize in each fiscal year, beginning with the fiscal year beginning July 1, 1938, a sum not to exceed $4,000,000—. The Secretary shall allocate one-fourth of such sum annually to each of the four laboratories established pursuant to this section."

The first year's allocation was the full 4 million dollars; the second year's, $3,200,000. If future appropriations should continue on this scale say $800,000 to $1,000,000 for each laboratory the scientific staff of each would number from 150 to 200 men, mostly chemists, physicists, biologists, and technologists expert in various industries.

In addition to authorizing the establishment of the laboratories, and the appropriation of necessary funds, Congress directed that a survey be conducted to determine the location of these laboratories and the scope of the investigations to be made; to obtain suggestions for needed research, and to coordinate the research work now being carried on.

This survey, which has now been completed, included a study of the research projects of the Department of Agriculture and other Federal agencies, the State experiment stations, educational institutions, privately endowed research institutions, consulting research laboratories, and the research laboratories maintained by industries which are based wholly or in part on utilization of agricultural raw material. This was accomplished very largely by personal contacts, visits and conferences, between individual members of a selected group of scientists from the Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture and the research directors and other leaders of the above-mentioned institutions. This information has been published in the form of a report and is now being used extensively in the formulation of the preliminary research program.

The next steps in establishing the laboratores involved the determination of the boundaries of the areas which were to make up the four major farm producing regions, and naming the surplus farm commodities on which scientists were to work during the initial program.

Of first importance were the natural boundaries determined by the long established agricultural practices and the principal crops grown. It is quite evident that the boundaries of these crop areas are over-lapping, and could not be followed in determining the boundaries of the regional areas. Therefore, various other factors were considered—farm population, value of farm property, cash income from crops and livestock, land in farms, and total land area. No single one of the four regions has less that 7% of the farm population or more than 34%. None has so little of the total value of farm property as to be considered of minor importance, and no area has so much that it might be considered overwhelmingly dominant. The same can be said of cash income. Crop income is fairly evenly divided as to the Southern, Eastern and Western areas. The Northern area, with 42% of the income, is not considered too much out of line when we take into account the other criteria, especially when we consider the type of agriculture and the surplus problems found there. Although the Eastern area has only 14% of the land in farms, it has 28% of the farm population. On the other hand, the Western area is the largest geographically, but the smallest in farm population.

After painstaking study of all the selected factors, the boundaries of the areas were determined. The designated areas are to be known as the Southern, Eastern, Northern and Western major farm producing

areas. The Eastern area includes the New England states, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, Kentucky, Tennessee and North Carolina. It is of first importance that the research load among the four laboratories should be equalized for the efficient performance of the task specified by Congress.

In the initial stages of the program, the work will be concentrated largely on the following farm commodities and their by-products; in the Eastern Laboratory, tobacco, apples, Irish potatoes, milk products, and vegetables; in the Southern Laboratory, cotton, sweet potatoes, and peanuts; in the Northern Laboratory, corn, wheat, and agricultural waste products; in the Western Laboratory, fruits other than apples, and vegetables, Irsh potatoes, wheat, and alfalfa. These commodities are the products in which the major surplus problems have occurred and are likely to continue to occur.

The definite selection of locations for the laboratories was next made after a careful study of more than 200 towns and cities. The Department was particularly gratified that a large number of these towns and cities were able to offer many of the special facilities required for this new research. This presented unusual opportunities for the selection of a suitable site for each of the laboratories.

The locations finally selected were

Eastern Region —Philadelphia Area
Northern Region—Peoria, Illinois
Southern Region—New Orleans, La.
Western Region —San Francisco, Bay Area

The selection of the cities in which the laboratories are being located was based partly on the physical and scientific requirements of the work, partly upon accessibility to the major farm producing areas, and partly upon the possibility of establishing relationships with the agricultural processing industries. The magnitude of the program to be undertaken, plus the special emphasis placed upon the development of articles for industrial use, makes it necessary that the laboratory be assured of adequate physical services; such as, water, gas, electricity, sewage facilities, etc.

The Eastern Laboratory is being built on a 32-acre tract of land at Wyndmoor, Pennsylvania, which is just north of Philadelphia. This location is accessible to the great processing industries along the Delaware River, and to reference libraries and research activities at the University of Pennsylvania and the Franklin Institute. The anticipated requirements of the laboratory for various physical services can be met here.

The building will be a U-shaped structure of three stories and basement. Offices, library, and conference rooms will be in the 211-foot base of the U, which will be the front of the building. One of the wings will contain research laboratories equipped for work in chemistry, physics, or biology. The other will contain a small number of laboratories and space for heavy engineering equipment. Service shops and special research rooms will be located in the basement. Both the offices and the laboratories will be air-conditioned. The building should be ready to occupy before July 1, 1940.

The program of research to be carried out here has as yet not been fully worked out. The Department is making a careful study of the inter-relationship between all the proposed new research and that already under way. Steps are being taken to avoid duplication and to make each part of the old and new research mutually helpful to all interested agencies. The first research projects undertaken will deal with the most important surplus commodities of this area; namely, tobacco, apples, Irish potatoes, milk products, and vegetables.

The fact that only these commodities are mentioned here does not indicate that the Department believes that other crops of this area are not important, or that research on certain other crops would not be profitable. Quite the contrary is true; but it is important that we confine our initial effort to a narrow enough objective so that our attack may be vigorous, not scattered and weak.

The research planned will not be simply research on specific problems as they arise, but a comprehensive, concerted, closely-knit program of research —chemical, physical, technological and economic— all carried on with the specific aim of finding new and extended uses for farm commodtities.

The interest in industrial utilization of farm crops was more or less moderate until the period following the World War when all at once the country was confronted with an aggravated problem of crop surpluses in addition to those problems of the profitable use of farm crop wastes and by-products. The persistence of these surpluses finally led to a realization that the problem must be attacked from various angles, of which industrial utilization is one. Now Congress has found it desirable to instruct the Department to put on more pressure in a certain field of applied research. This makes possible for the first time a comprehensive program of research carried on with the specific aim of finding new and extended uses for farm commodities.

A number of farm products are being used for industrial purposes today, but the quantity of farm crops used by industry for purposes other than the conventional food, raiment, and shelter is very small compared to the amount produced, or the surpluses that exist in some of the major commodities. Most of the six or seven hundred million pounds of cereal starch that are produced in this country are made from corn. Such chemicals as acetone, butyl alcohol, citric acid and others may be made by controlled fermentation of products derived from corn. Cottonseed was at one time merely a waste if not a nuisance. Then processing for recovery of cottonseed-oil began. Now the cash value of the seed equals about sixteen percent of the value of the cotton crop. Synthetic fibers and other cellulose plastics are now manufactured in large quantities from cotton linters.

This type of research is not new in the Department of Agriculture. This very Bureau of the Department has made a number of distinct

contributions in this field, several only recently. Furfural is made from waste oat hulls by processes which originated in laboratories of the Bureau. Calcium gluconate, a medical product of considerable importance made from corn sugar is another result of researches of the Bureau. Research at the Soybean Laboratory has given us a varnish that is made with soybean oil. Investigations by the Carbohydrate Division of our Bureau has resulted in the commercial production of sweet potato starch. This starch can take the place of imported root starch, of which some three to four hundred million pounds are imported annually into this country.

Now the work of the regional laboratories will greatly expand this type of research. These laboratories will make possible a more extensive and concerted attack on the problem of surplus. As I said before, the initial program will deal with the major surplus crops of each area. In the East to start with we will be concerned with tobacco, apples, dairy products, potatoes and vegetables.

Two types of research will be undertaken in these laboratories. One will be research into new fields in which little or no work has been done. This might be called exploratory research. The other will be research on what we may call waiting problems. The potato crop is a good example of a waiting problem, since quite a bit of research has already been done in developing potato starch. Much more can be done, particularly in the direction of improving quality and cutting the cost of manufacture. It is also possible to make modified starches and starch derivatives. It may be possible to produce some of these useful products in continuous process in starch making.

A promising development in utilization of potatoes is the application of new methods of chemical treatment to precede drying and make drying easier. Low cost dehydration offers a way to cut transportation and storage costs, thereby making the dehydrated product available as a cheaper raw material.

We grow an average crop in this country of about one and one-third billion pounds of tobacco, a lot of it formerly going to export. Now we are running into sharper and sharper foreign competition aided by tariffs and other controls. There has been a steady decline in our exports of fire-cured and dark air-cured types. You have noted the demoralizing effect on the tobacco market caused by the recent withdrawal of British buyers. More and more we are forced to depend on domestic outlets for our tobacco.

Let me point out a few of the items listed in our research program looking to the development of new and extended uses of tobacco. Work will be undertaken with a view of extending the uses of nicotine for use in insecticides. Nicotine is by far the most important by-product of tobacco. It is an efficient insecticide, which can be applied in vapor, liquid, or solid state and it is believed its use can be greatly extended. In this connection it is planned to conduct agronomic and chemical investigations in cooperation with the production research of the Department and of the State Experiment Stations to develop high nicotine tobaccos which would be suitable for industiral production of nicotine and other products.

Then there is the question of uses of tobacco constituents other than nicotine. About thirty different constituents of tobacco are known, some of which are specific and peculiar to tobacco. Among these substances might be mentioned alkaloids other than nicotine, organic acids, essential oils, plant pigments, pectin, etc. It is planned to study practical methods of isolation and the economic possibilities for commercial exploitation of these substances.

Researches also will be conducted in cooperation with other Federal and State agencies on the effects of cultural, varietal, environmental, and processing factors on the composition of tobacco and on the correlation of relationships between composition and tobacco quality. It is hoped that such studies will give us a better understanding of what tobacco quality really means and may furnish the information necessary in attempts which will be made to modify suitably by physical or chemical means certain tobacco types which are in great surplus, and thus divert them into more profitable channels.

Our enormous dairy industry turns out annually more than 100 billion pounds of milk. This represents 13 billion pounds of solids in the form of fats, proteins, carbohydrates and salts. This huge output represents approximately 20% of the total farm income, and approaches the combined value of cotton, wheat and tobacco.

The problems of the dairy industry are very complex. Milk surpluses do not exist in the sense that there is a large carryover from one period of excess production beyond the next one. Ordinarily all milk not sold for fluid consumption is converted into the more stable manufactured products such as butter, cheese, etc. Milk as such for human consumption commands a price far in excess of that obtainable for any other purpose; hence milk surpluses become more apparent in unsatisfactory returns for the secondary products. Consequently much of the research effort in the past has been devoted to the development of new and improved secondary products.

Intimately associated with this need has been the problem of finding a more profitable and effective means for the utilization of the principal dairy by-products, skim milk and whey. About 54 billion pounds containing about 4.8 billion pounds of milk solids, chiefly casein and milk sugar, are annually available. This presents the problem of finding such increased uses for casein and lactose, as will bring the greatest return.

Some progress has already been made in this direction. Domestic casein production has increased from 18 million pounds in 1921 to about 72 million pounds in 1937. At present this is used largely for paper sizing and glue. The present uses for lactose are so few as to require only a small percentage of the total amount available. Increased utilization of lactic acid, which is obtained from the milk sugar of whey by a fermentation process, offers promise of more profitable utilization of whey. At present about 5 million pounds of whey are fermented annually to make lactic acid.

In addition to studies directed to new and extended uses for casein and lactose other studies are planned; for example on the chemistry of whey protein, and devising industrial uses for it. Studies will be carried on for improving the methods of concentrating riboflavin from whey, and application of knowledge of the characteristics of riboflavin to devising industrial uses for this substance. All in all dairy products offer a tremendous field for constructive research effort.

Apples

And now I come to apples, and I am sure you are particularly interested in the work on apples that is planned for the Eastern Laboratory.

The Atlantic Coast States constitute a leading apple producing area, although the surplus apple situation is as serious in the Northwest as anywhere in the country. Increased competition from other fresh fruits, particularly citrus fruits, the large loss of our apple export trade, and other economic factors, have been primarily responsible for large surpluses of marketable apples and unsatisfactory price conditions. In addition to large surpluses of first-grade apples enormous quantities of culls accumulate annually, for which new profitable uses are urgently needed. Approximately 20% of the total apple crop is used in the preparation of apple products such as cider, vinegar, canned applesauce, etc. In these processing plants large amounts of pomace, seeds and other by-products occur which are largely wasted.

As a raw material for preparation of products for other than food or beverage uses, the apple is relatively expensive, since it contains over 85% of water. Transportation costs to processing plants constitute an important item for any method of utilization. In the case of cull fruit, which is sorted out at the packing plants, and the by-product materials available at processing plants, transportation costs are borne entirely by the present salable products. For the utilization of surplus fruit, however, which in many instances is not harvested, it will be necessary to find such profitable uses as will carry the entire cost of production, collection, transportation, and processing. It becomes apparent, therefore, that the development of profitable industrial outlets for apples probably in the main will be confined to surplus fruit in areas of heavy production, to cull apples, and to the pomace available in processing plants.

In considering new uses for the apple, its composition is of prime importance. The dry matter of this crop consists chiefly of fermentable sugars and pectin, with minor amounts of cuticle wax, protein, fat, fiber, malic acid and mineral constituents. Of these constituents pectin and cuticle wax offer the greatest promise in development of non-food uses. Comprehensive chemical studies to supplement our present inadequate information on the composition of different apple varieties at different stages of ripening will be conducted. More complete information concerning the individual constituents of apples thus made available will be of fundamental importance in determining possible new uses which may be developed.

Problems on storage, preservation and dehydration will be attacked. Studies on apple pectin, particularly with respect to pomace as a source of this material will be made. The constituents of cuticle wax will be separated and their chemical properties elucidated. Industrial uses for the wax itself will be investigated. Of special significance is the constituent ursolic acid which may provide an economical source of raw material for the synthesis of such pharmaceuticals as the sex hormones.

In addition, investigation of the seed components, fermentation studies, and studies of the other apple constituents will be made. All of this work will be correlated with economic studies to determine the feasibility of developing these non-food uses for apples.

Many interesting possibilities for development of new and improved apple food products such as concentrates, sirups, and similar products exist, and this field will by no means be neglected. A program of research to serve as a basis for utilization of apples will be most effectively pursued by close coordination with economic surveys and analysis.

Vegetables

During recent years a definite trend for inclusion of a larger proportion of vegetables in the diet has developed. This has resulted in a three-fold increase in the acreage of truck crops since 1920. Notwithstanding the large increase in production, the income to the farmer for these truck crops has not increased. They received a total income of about 250 million dollars twelve years ago, and about the same amount for twice the quantity of crops during the last five years. Surplus of market vegetables and carry-over of canned goods have combined to depress prices in recent seasons. This in spite of the fact that introduction of new methods, such as the quick-freezing industry, has opened new fields for year-around retail distribution of vegetables.

All vegetables are grown primarily for food use, and in the handling of vegetable crops, there are large tonnages of discarded material that cannot go into food channels. Trimmings, low grade, off-standard and cull materials accumulate at central distribution points and processing plants. This is an important factor when concentration of raw materials and availability for industrial utilization are considered.

The need for a definitely formulated program for intensive research in the utilization of surplus, culls, and waste from truck crops is emphasized by the tremendous quantities of material available and the limited amount of research now under way. In most cases these wastes are already serious problems, because they constitute actual nuisances that require early attention to prevent danger to water supplies or public health and comfort.

It should be pointed out that in any program dealing with the development of industrial uses for vegetable material the fact that these materials are produced in widely scattered areas of the country must be considered. Many of them are of a highly perishable nature, which is a serious obstacle to overcome in the development of a program for their utilization. The most serious handicap in development

of uses for these commodities is their low content of constituents now having industrial value. Knowledge of the chemistry of many of these constituents is inadequate, which makes more difficult the problem of their isolation and characterization.

The program of research on vegetables will include such studies as the effect of nutrient and climatic conditions and varietal changes on the kind and amounts of various chemical constituents produced in the roots, stalks, leaves and seeds of vegetables. Studies of this sort offer a logical attack on the problems of developing cheaper, better balanced commodities, and may point the way to development of types of vegetable products rich in some constituent suitable for industrial utilization. It is also planned to make a complete inventory of constituents occurring in vegetables. Knowledge made available by these studies will aid in evaluating the possible industrial uses for different vegetables.

Studies of methods of isolation, properties of, and wider uses for other vegetable constituents will be carried out. Such substances as carotinoid pigments, flavins, chlorophyll, anthocyanins, pectin, oils and fats, vegetable waxes and various by-products from vegetables offer a wealth of material for investigational work. Many of these substances have been studied to such a limited extent that the meager information we possess is not sufficient to judge as to their worth for industrial use.

Microbiological studies on vegetables with the aim of developing useful materials, and methods for development of artificial manures from vegetable wastes will also be investigated. With this work as with work in other lines, any promising laboratory results will be transferred to the pilot-plant scale, where chemical engineering studies will be made with a view to subsequent transfer to industrial processes.

The importance of economic studies as an integral part of the research program on vegetables cannot be over emphasized. A broad economic survey of the actual and potential surpluses and their geographical distribution, particularly in relation to existing processing facilities will be made.

It seems very fitting indeed here in this Eastern area, where the nation's industry rubs elbows with agriculture, that an institution of the nature of the Eastern Regional Laboratory be created. This laboratory and the other three now being established have been created by Congress to deal with the specific problem of finding new and wider industrial outlets for agricultural products. That is their job and they will confine their efforts to that problem. During the survey, which I mentioned previously, representatives of the Department visited hundreds of laboratories in the Eastern area. We received universal and cordial cooperation and we feel that this cooperative spirit will continue to be manifested in the development of detailed research programs and in the carrying out of actual laboratory investigations. This cooperation we earnestly seek. We want the experiment stations, the universities, farm organizations, and industries in the sixteen states that comprise the Eastern Region to be convinced that this laboratory will render the greatest service to agriculture and to the region as a whole when we all pull together.

INJURY FROM SPRING APPLICATION OF FERTILIZERS TO STRAWBERRIES

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First or Setting Year

For the past two years we have had almost a total collapse in our strawberries. In response to a call for help, Dr. Manns and Dr. Stearns with several assistants —Dr. Darrow and four other learned Federal experts came to help us out of our difficulties.

I feel that it is only fair for me to express a word of commendation for the way in which the members of the University of Delaware staff took hold of this problem. They most certainly deserve praise and really the credit for the test put on at our place. It was through them, too, that we had the attention of the government specialists.

The day the experts were with us, Dr. Darrow asked if there had been any spring applications of fertilizers. When he was about ready to go he came over to me and told me "sorta" confidentially like, that hereafter instead of buying the fertilizer, just to give him the money he needed it and it would do the berries every bit as much good. That remark of Dr. Darrow's was in direct variance with general opinions and put a question mark after spring fertilizers for strawberries. It had a lot to do, too, with this test at our place being started. The use of a complete fertilizer, 4-8-7, about 300# per acre, was more or less an accepted practice, especially in hold over patches.

We talked a little to a few strawberry men. One grower said that if he hadn't used a complete fertilizer on his patches he wouldn't have had any berries to pick —his applications were made March 1. Another man believed in bone meal "first, last and forever." Another - "January 1st treatments give wonderful results." We read some reports from a horticultural meeting taken from different state tests "Acid Phosphate used in connection with either dried blood or nitrate of soda increased yield." "Acid phosphate has shown no effect, while nitrate of soda and muriate of potash have been found to be harmful." From a catalog, a plant grower recommends 800# per acre of Kainit before or after setting, or, in lieu of the 800# of Kainit, use 400# of muriate of potash. We had a yellow sheet of fertilizer recommendations sent us that says to use from 300 to 600 pounds per acre of 3-12-6 at setting time or an equal amount of 5-8-12 as a side dressing. This was all more or less confusing.

Let me quote from another source —a source, too, for which I have a great deal of respect. "Salts of nitrogen and potash should never be put on where they come in contact with the roots of strawberry plants." To quote further, "We believe that most soils have sufficient potash for strawberries. We have never seen any direct